



## Marine Loss Control Engineering (MLCE) Container Stack Failures on High Seas



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# Marine Loss Control Engineering (MLCE)

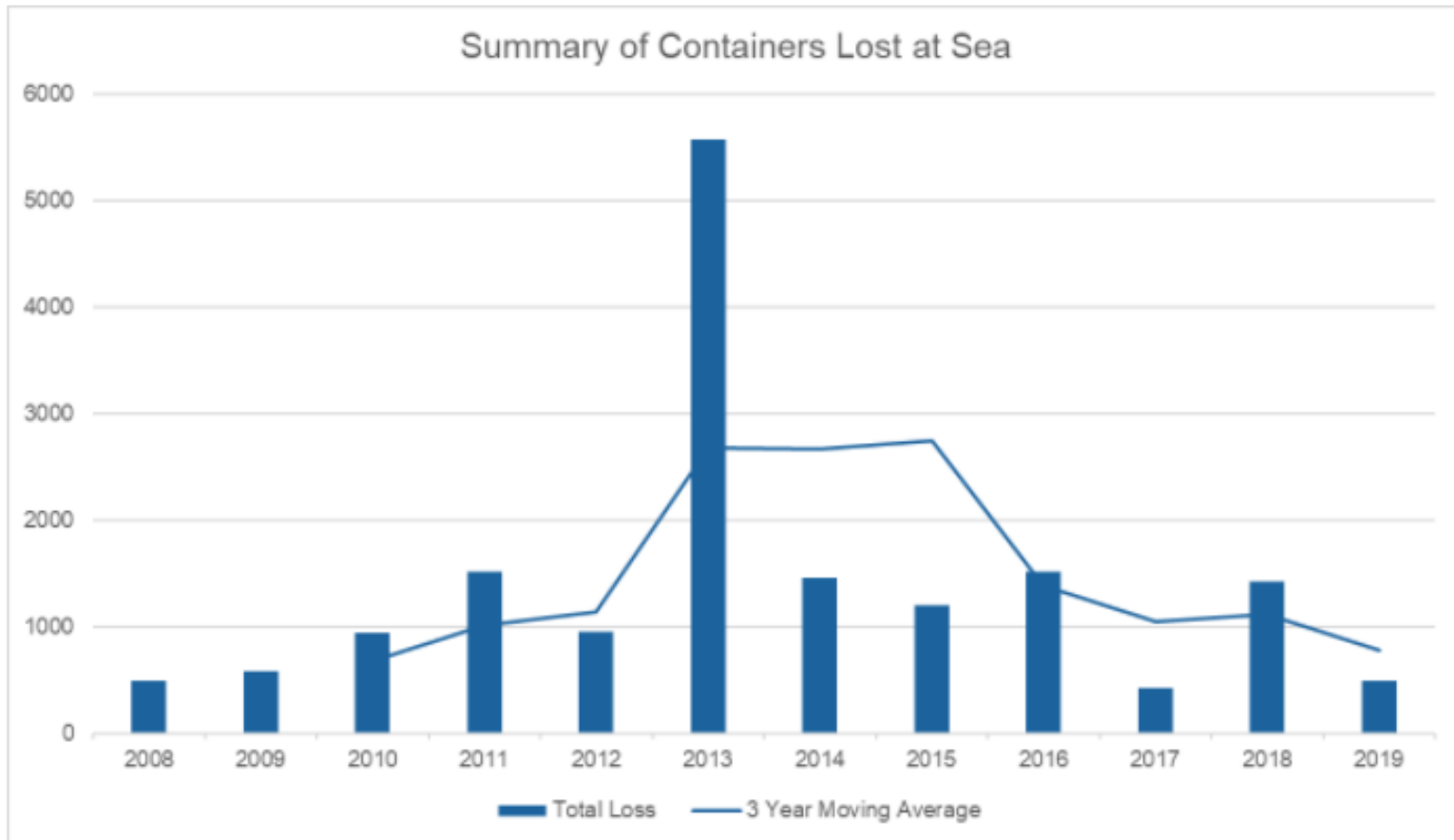
## Container stack failures on high seas

### ■ Agenda

- Incidents over the years
  - Know incidents with vessels
  - Type of vessels
  - Type of containers
  - Lashing standards
  - Acceleration forces explained
  - Various cause of stack collapses explained
  - Questions
- MSC Zoe, debris washed ashore



# Statistics



Source World Shipping council [https://www.worldshipping.org/Containers\\_Lost\\_at\\_Sea\\_-\\_Update\\_FINAL\\_.pdf](https://www.worldshipping.org/Containers_Lost_at_Sea_-_Update_FINAL_.pdf)

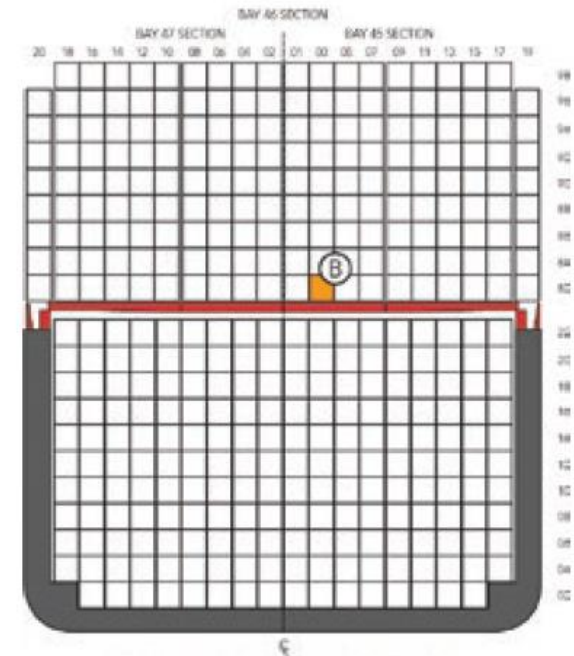


# Incidents where container vessels lost containers only

# Containers Lost	Ship Involved	Where	When
260	MAERSK EINDHOVEN	Pacific Ocean	2021
750	MAERSK ESSEN	Pacific Ocean	
76	E.R. TIANPING	Pacific Ocean	
40	MSC ARIES	Pacific Ocean	
40	APL ENGLAND	Australia	2020
23	MSC PALAK	South Africa Coast	
33	FRANCISCA	Scotland	
100	ONE AQUILA	Pacific Ocean	
1816	ONE APUS	Pacific Ocean	
21	EVER LIBERAL	Japan	
200	MAERSK MUNICH	German Bight	
350	MSC ZOE	German Bight	2019
43	KSL GLADIATOR	Indian Ocean	
2	MAERSK SEOUL	Indian Ocean	

# BAY – ROW - TIER

- All the containers can be found with a unique number on the stowage plan
- Bay numbering from Forward to Aft uneven for 20' even numbering for 40'
- Row numbering from centerline Stb or Port
- Tier number from first tier in the bottom and upward



Stowage plans cargotec McGregor unlimited use approved

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# Type of containers

- There are 8, 10, 20, 40, 45 foot containers
- Open top containers
- High cub containers
- Reefer containers
- Tank containers
- Insulated containers
- Flatrack containers
- Bulk containers
- Office containers



## Standard

20', 40' and 40' Highcube



## Open top

20' and 40'



## Flat rack

20' and 40'

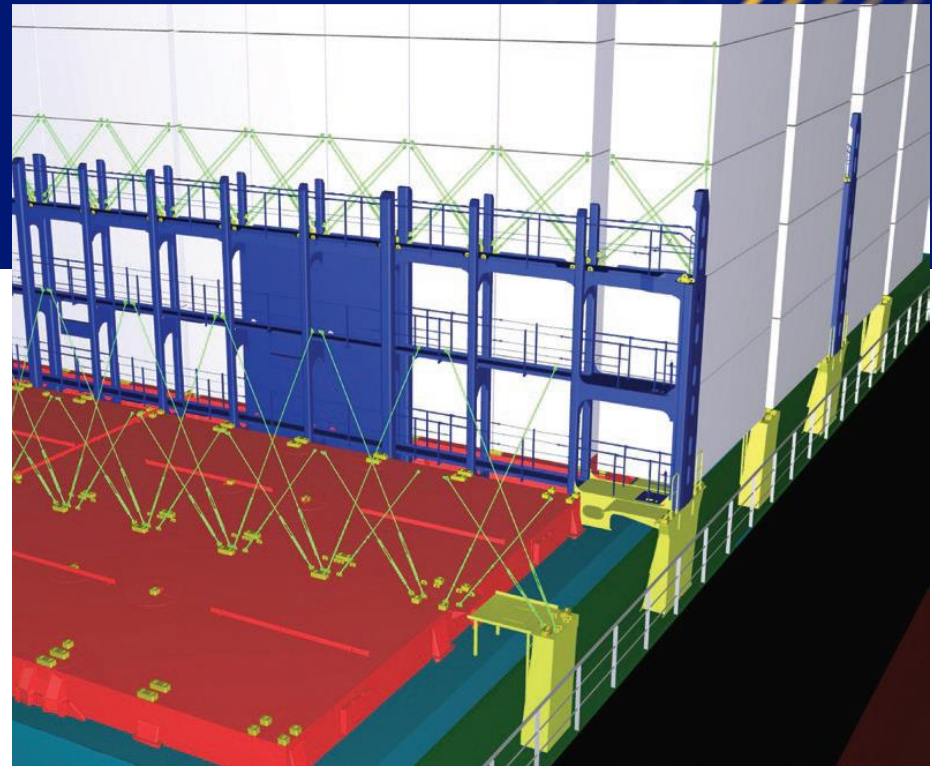


## Pallet wide (Seacell)

20' Highcube, 40', 40' Highcube, 45' Highcube

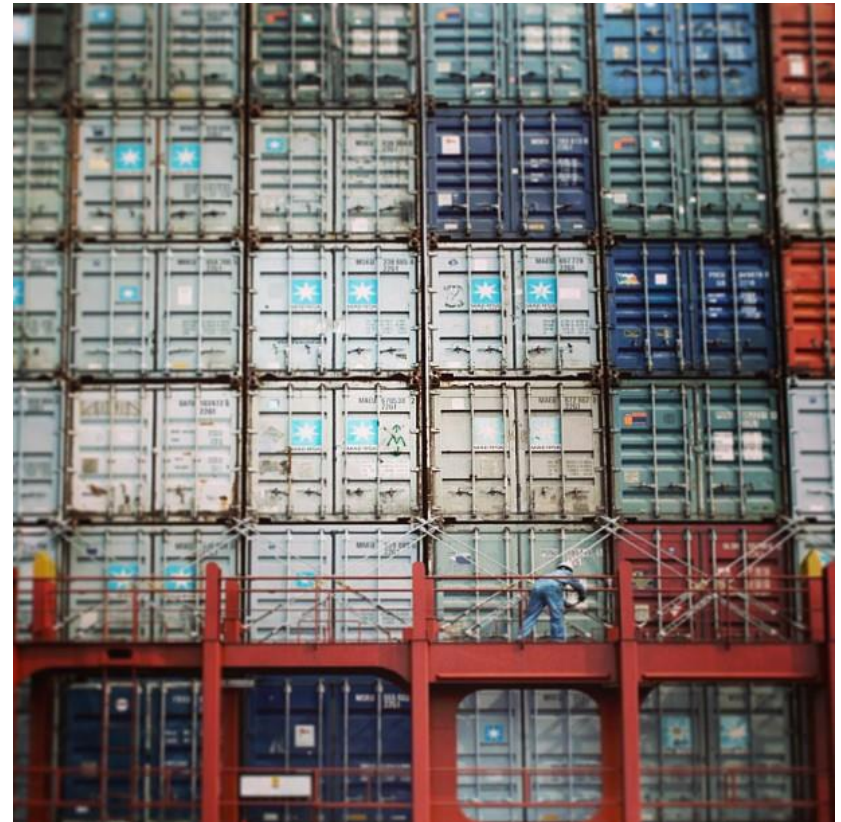
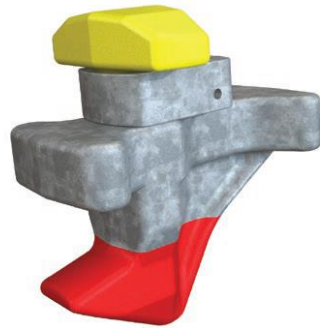
# Container lashing standards

- Under deck container are loaded in cell guides,
- On deck containers are stacked on top of each other and vertically locked with container twistlocks,
- In addition the bottom tiers on deck can be secured with lashing rods and turnbuckles,
- To increase the stacking height on deck in particular the large vessels are designed with lashing bridges
- Lashing bridges can be of 1 and upto 5 tiers high. This enable the lashing with lashing rods another 2 high containers above the lashing bridges.



# Type of twistlocks

In the basic the purpose of the twistlock is to lock/connect stacked containers to each other and prevent same from toppling over or sideways sliding.



MACGREGOR  
<https://commons.wikimedia.org/wiki/Category:Maersk>



# Lashing bridges

- My view is that lashing bridges are essential for on deck container securing, in addition to the twist locks
- My view is also that from high lashing bridges (5 cont high or more) fire fighting and sprinklers would be possible to attach



# Full Cellguides, High lashing bridges, low lashing bridges



Full cell guides on deck





# Full Cellguides, High lashing bridges, low lashing bridges

- Low Lashing bridges

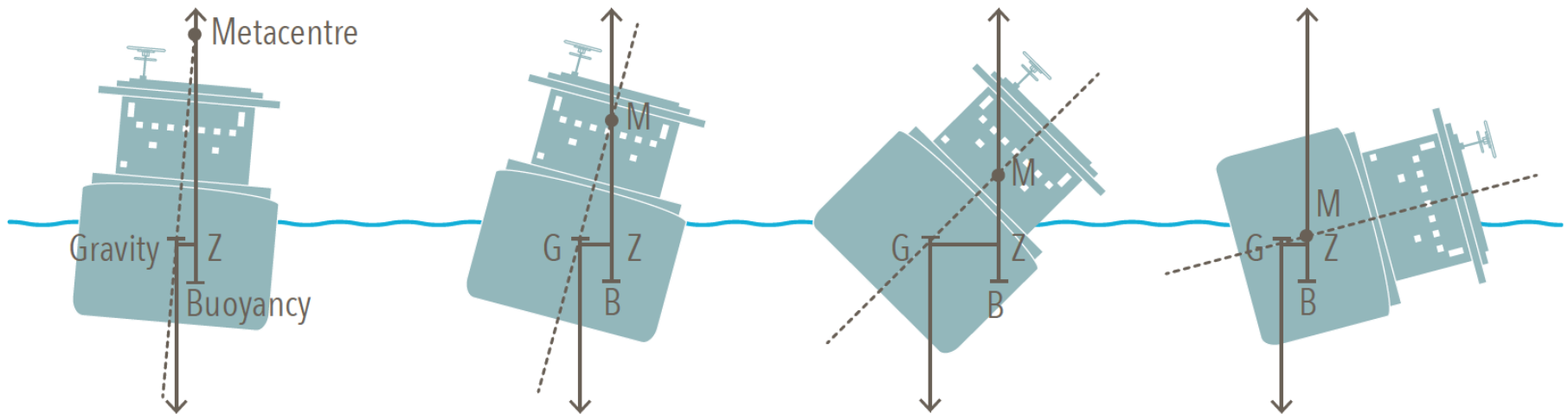
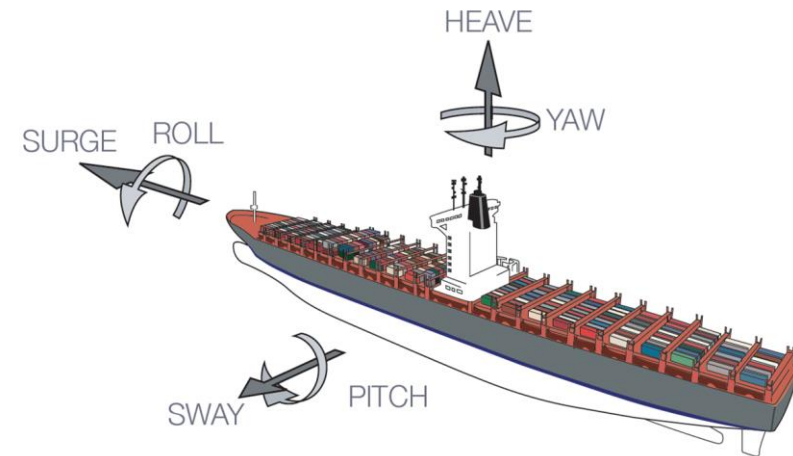
Source Shutterstock



# Actual acceleration forces acting on a vessel

## Actual versus design criteria

- Stability is expressed in GM,
- A low GM figure gives a "soft" vessel, with slow rolling period
- High GM figure makes a vessel stiff, with a fast-rolling period





# Ships Cargo Securing Manual

## CSM

- The cargo securing manual of the latest generation container vessels is based on design of the vessel and as per IACS recommended Global wave statistics,
- The basis are the designed rolling angles and a design stability parameter,
- The container vessel rolling angle design is in range of 15 to 20 degrees,

Questions remain...

Does the vessels staff increase the lashing arrangements if the GM appears to be more than the designed GM?

Does the vessels staff increase the lashing arrangements if the weather conditions are likely to exceed the CSM criteria?

# Cause of a collapse of a container stack

## Lessons learned identified various scenario's

1. Structural container failure due to wrong stowage and securing standards of product inside the container,
2. Structural container failure due to aging or excessive wear and tear,
3. Miss declared container weight, (VGM)
4. Improper container lashing and securing,
5. Impact by green water,
6. Actual acceleration forces are in excess of the vessels design criteria,
7. Synchronous rolling,
8. Parametric rolling.

# Structural container failure

Due to improper cargo packing, stowage and/or securing standards

Goods improperly packed, stowed and/or secured inside the containers are often the cause of cargo shifting and consequently destruction of the container integrity.

Good practices can be found in the CTU Code:

[https://unece.org/fileadmin/DAM/trans/doc/2014/wp24/CTU\\_Code\\_January\\_2014.pdf](https://unece.org/fileadmin/DAM/trans/doc/2014/wp24/CTU_Code_January_2014.pdf)



# Structural container failure

Due to aging and/or wear & tear

- Severe corrosion,
- Historic mishandling,
- Frequent exposure to hars conditions,
- Bottom deformed by heavy point loads.

<b>APPROVED FOR TRANSPORT UNDER CUSTOMS SEAL</b>	
<b>M/DF-7524-326/2008</b>	
TYPE <b>NT40C-159A</b>	MANUFACTURER'S NO. <b>NBA109026005</b> OF THE CONTAINER
MANUFACTURED BY: <b>CONTAINER MANUFACTURE</b> LOGISTIC EQUIPMENT CO., LTD	MANAGING AND OPERATED BY: ISF SHIPPING COMPANY S.A 47 Avenue Pierre Brossolletta, 92120 Montrouge - FRANCE TLX: 417486 MSC CH, FAX: +4162 793 6085 OWNED BY:
TIMBER COMPONENT TREATMENT IM/MEGANIUM 2000/2007	
<b>CSC SAFETY APPROVAL</b>	
<b>E-KL-4092/GL 9278</b>	
DATE MANUFACTURED	<b>06/2009</b>
IDENTIFICATION NO.	<b>RTHU153478-7</b>
MAXIMUM OPERATING GROSS MASS	<b>30.480 KGS 67.200 LBS</b>
ALLOW. STACK. WT. FOR 1.8G	<b>220.570KGS 499.720 LBS</b>
RACKING TEST LOAD VALUE	<b>15.240 KGS 499.720 LBS</b>
<b>ACEP</b> FR-BV 2012-001	

Inspection must be carried out as per IMO Convention of Safe Containers

[https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-Safe-Containers-\(CSC\).aspx](https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-Safe-Containers-(CSC).aspx)

Responsibility lies with the container owners/operators.





# Miss declared container weight

## Solas - Verified Gross Mass

- General principle is that heavy containers are loaded in the bottom and lightweight containers in the top,
- If the weight is not correctly done it may end up in a wrong position on board,
- Since July 2016 shippers are obliged to provide the carrier with a confirmation of the total weight of the container and cargo before loading on board the vessel, (VGM)
- Stowage planning is done by shore based personnel and mainly with the aid of computed container planning programs,
- Experience learned that at times late arriving heavy containers are loaded in a top stowage position on deck.

**A too heavy container in top can be the cause of a stack collapse!**

# Improper container lashing and securing

- Twistlocks not properly fitted,
- Failing twistlocks due to poor maintenance,
- Lashing bars not tightened,
- Failing to place lashing bars at all,
- Wasted container foundations on ships weather deck,
- Containers improperly stowed.



## Impact by green water

The impact of green water or massive sea waves can be too such extent that it damages the container and that loses its integrity.



Top picture Hervé Cozanet, CC BY-SA 3.0 <<http://creativecommons.org/licenses/by-sa/3.0/>>, via Wikimedia Commons  
Left picture AIG Risk Consulting Photo Library

# Parametric rolling

- Happens basically to the larger container vessels i.e 10.000 TEU and above,
- Happens when the vessel sails in head or stern seas,
- Caused when waves are rolling from fore to aft and immerse the bow and stern flairs in a synchronische pattern,
- The container vessels are designed with relatively large stern and bow flairs,





# What is next?

## How to stop these events?

- Influencers are
  - Shipping companies (Mearsk, MSC, CMA CGM, NYK, MOL, Evergreen)
  - Flag states
  - IMO International Maritime Organization
  - Class societies (IACS)
  - P&I Clubs (IGP&I)
  - Environmental organizations
  - International Chambers of Shipping (ICS)
  - IUMI

**Is this a long route? Or do we first need a total loss of a vessel?**

# THANK YOU FOR YOUR PARTICIPATION QUESTIONS?



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